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Consensus statement of the Paediatric Section of the Polish Society of Anaesthesiology and Intensive Therapy on general anaesthesia in children over 3 years of age. Part II

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ANAESTHESIA IN LARYNGOLOGY

PREPARATION FOR ANAESTHESIA

Anaesthesiologists feel no need to perform additional examinations for typical procedures, such as adenoidectomy and adenotonsillotomy or adenotonsillectomy, in children in good general health with no history of bleeding incidents [1]. Laryngologists often order coagulation tests, which are necessary in patients with a positive bleeding history from the nose, gingivae, ear, etc.. Blood group determinations are useful before tonsillotomy or tonsillectomy because of an increased risk of intra- and postoperative bleeding.

It is essential to determine whether patients have symptoms of obstructive sleep apnoea syndrome (OSAS) associated with tonsillar hypertrophy, upper airway structural defects, obesity, or impaired breathing regulation [2,3]. These patients (whose major symptom is snoring) are likely to have cardiovascular disorders (e.g., arterial hypertension and occasionally pulmonary hypertension) that require additional cardiologic evaluation.

The chest X-ray should be performed in every child with the suspicion of aspiration of foreign body.

PREMEDICATION

Children with a good general health status may be premedicated orally – predominantly with 0.3 mg kg^{-1} midazolam 20–30 min before anaesthesia or 0.5 mg kg^{-1} midazolam (unless OSAS is present) 30 min before anaesthesia. Premedication may be abandoned in cooperative children and/or children with pre-existing peripheral venous access. Dexamethasone (0.1 mg kg^{-1}, max. 4 mg) administration prior to intubation reduces the risk of postoperative nausea and vomiting (PONV). Ondansetron (0.10–0.15 mg kg^{-1}, i.v.) is effective in high PONV risk surgical procedures.

ANAESTHESIA

The following induction methods may be used in children with good general health status:

1. Inhalation induction with sevoflurane in a mixture of oxygen and N_2O or oxygen and air. Increased continuous positive airway pressure (CPAP) should be maintained in OSAS children to prevent airway obstruction.
2. Intravenous induction with propofol, thiopental or ketamine. Ketamine is particularly suitable for children with unstable circulation accompanied by bleeding when spontaneous respiration must be preserved [4]. Endotracheal intubation is necessary in most procedures following the administration of a short- or medium-acting muscle relaxant (e.g., mivacurium, rocuronium or atracurium) depending on the type of surgery or preferences of anaesthetists. Endotracheal tubes with sealing cuffs or sealing of the laryngeal aperture using roll gauze and right angle endotracheal (RAE) tubes or reinforced tubes are recommended in adenoidectomy or tonsillectomy cases. The former tube type prevents blood from leaking into the trachea, and the latter tube types prevent tube kinking.

MAINTENANCE OF ANAESTHESIA

Combined general endotracheal anaesthesia is preferable for anaesthesia maintenance. Total intravenous anaesthesia (TIVA) with propofol and remifentanil is used in special cases, e.g., middle ear or nasal septum surgery. Anaesthesia with sevoflurane combined with an analgesic (metamizole or paracetamol intravenously or rectally) is adequate in simple procedures (e.g., incision of the tympanic membrane). An alternative is short intravenous anaesthesia (e.g., propofol or remifentanil). Nitrous oxide should be avoided during tympanoplasty or tympanic membrane transplantation because it permeates to closed spaces and induces hypertension.

OPTIMAL ANALGESIA

Optimal analgesia is generally provided using the synthetic opioids fentanyl (1–3 mcg kg^{-1}) or sufentanil (0.1–0.3 µg kg^{-1}). Remifentanil infusion may be used without an initial bolus because of the risk of bradycardia. Opioid analgesia is supplemented with rectal ibuprofen (6–10 mg kg^{-1} in children above the age of 3 months) and/or *i.v.* or rectal paracetamol (15–20 mg kg^{-1}), optimally preemptive administration [4].

AWAKENING

Awakening in the lateral decubitus position is preferable after pharyngeal surgical procedures using a no-touch technique, which reduces the risk of laryngospasm [5]. Lidocaine (1 mg kg^{-1}, *i.v.*) may also be administered prior to extubation. Nalbufin (0.1–0.2 mg kg^{-1}), paracetamol, or metamizole should be used to reduce postoperative pain.

SPECIAL CASES

These cases primarily include foreign body removal from the trachea or bronchi and re-adenoidectomy or re-tonsillectomy due to bleeding. In the former case, the insertion of a ventilation bronchoscope into the airway after anaesthesia induction (any method can be applied) and short-term relaxation (succinylcholine is acceptable) is recommended for re-adenoidectomy. The combined method is preferable for maintenance, e.g., intravenous-inhalation with sevoflurane in a mixture with 100% oxygen. Re-tonsillectomy patients should be managed like a patient in shock and a child with "full stomach". Induction with ketamine and rapid sequence induction with succinylcholine or rocuronium are recommended [4].

ANAESTHESIA IN COMPUTED TOMOGRAPHY AND MAGNETIC RESONANCE IMAGING ROOMS

The magnetic resonance imaging (MRI) room should be equipped with devices designed for strong electromagnetic fields, i.e., without ferromagnetic elements, including an anaesthesia machine, cardiac monitor, and laryngoscope. Earplugs or earphones should protect the child because of the noise intensity of up to 95 dB. Standard equipment may be used if the MRI room is not equipped with the aforementioned devices, provided it is located outside the room and is connected to the patient with suitably long wires and pipes.

There are no special anaesthetic equipment requirements for computed tomography (CT) rooms. However, the anaesthesiologist is generally outside the CT room during anaesthesia or examinations, and the patient is beyond direct visual range. It is essential to have good monitoring devices to enable SaO_2 measurements and capnometry [6].

PREPARATION FOR ANAESTHESIA

Children do not have to be specially prepared for the examinations mentioned. The child should be examined for implants with ferromagnetic elements prior to MRI. Aluminium, nickel, high-quality steel, titanium alloys are acceptable and safe. Children with pacemakers should not undergo MRI because of a high risk of device dysfunctions, including complete re-programming. Serum urea and creatinine determinations are required prior to contrast-enhanced examinations [7].

PREMEDICATION

Premedication is not always necessary, but midazolam (0.3–0.5 mg kg^{-1} orally or 0.1 mg kg^{-1} *i.v.*, max. 10 mg) is most commonly applied.

ANAESTHESIA

Inhalation or intravenous anaesthesia is used (e.g., sevoflurane, propofol, or ketamine). Most CT examinations require short-term sedation (up to several minutes), most commonly with age-appropriate doses of propofol doses (2–4 mg kg^{-1}) to preserve spontaneous breathing. Substantially deeper and longer anaesthesia (20 min to 1–2 h) is required during MRI, such as, TIVA with the propofol infusion rate adjusted to the patient's age and condition (frequently 10 or more mg kg^{-1} h^{-1}), which may be accompanied by impaired airway patency. Success in numerous cases is determined by complete patient stillness. Opioids are required for intubation or insertion of a laryngeal mask. Notably, impaired airway patency in patients with preserved spontaneous breathing (without devices supporting its patency) may result in position changes, which impairs examination quality [8].

MAINTENANCE OF ANAESTHESIA

Volatile induction and maintenance of anaesthesia (VIMA) (sevoflurane) or TIVA (especially when anaesthesia machines adjusted to work in an electromagnetic field are unavailable) may be used.

AWAKENING

Children should be preferably awakened in the recovery room setting in the immediate vicinity of the MRI room or in the operating suite according to accepted standards.

ANAESTHESIA IN ORTHOPAEDICS

Anaesthesia in paediatric orthopaedics is extremely challenging for anaesthesiologists. Orthopaedic surgeries range from simple, uncomplicated procedures in healthy children to more complex procedures or procedures performed in children with concomitant severe systemic diseases or congenital defects. The first group includes long bone fractures or congenital bone deformities of slight and medium severity (e.g., talipes equinovarus), generally in otherwise healthy children (ASA I–II). The second group (ASA III-IV) is comprised of severe congenital skeletal deformities (e.g., scoliosis) or skeletal deformities coexisting with other diseases, such as neuromuscular dystrophy, arthrogryposis, cerebral palsy, paraplegia or rachischisis.

PREPARATION FOR ANAESTHESIA

Children with severe skeletal deformities are predominantly characterised by reduced respiratory and/or circulatory efficiency, impaired CNS functions of various severities or metabolic diseases. The coexistence of neuromuscular diseases is an essential factor of increased risk of malignant hyperthermia. The aforementioned patients should only undergo surgery in highly specialised orthopaedic centres, which provide a continuation of treatment in paediatric intensive care units.

Another group includes patients who are qualified for emergency or urgent orthopaedic procedures diagnosed with isolated or multiple organ injuries. These patients should undergo complete radiological diagnostic procedures. Craniocerebral trauma must be excluded, and the actual time between the last meal and trauma must be assessed because of the risk of aspiration during induction, which is high even after slight injuries [9]. The risk of intraoperative bleeding should be estimated during the initial examination, and adequate preparations should be readied (e.g., red cell concentrate, fresh frozen plasma, platelets or cryoprecipitate):

$$\text{MABL} = \text{EBV} \times (\text{patient's haematocrit} - \text{minimum acceptable haematocrit})/\text{patient's haematocrit}$$

where
MABL — maximum allowable blood loss
EBV — estimated blood volume

The incidence of fat emboli in long bone fractures in children is lower than adults. However, the development or co-existence of consciousness disorders and deep hypoxaemia may arouse such a suspicion [10, 11].

PREMEDICATION

Oral midazolam (0.3–0.5 mg kg^{-1}) is recommended in anxious and uncooperative children. Patients with coexisting pain should also receive analgesics (e.g., paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), or opioids)

or ketamine (3–5 mg kg^{-1}). Dexmedetomidine (Dex) (oral 2.5 μg kg^{-1} or intranasal 0.5–1 μg kg^{-1}) and clonidine (Clo) (oral 4–5 μg kg^{-1} or intranasal 2–4 μg kg^{-1}) are an alternative, especially in hyperexcitable children. Laboratory examinations should include blood tests, electrolytes, blood group determinations and coagulation tests for procedures with a risk of intraoperative haemorrhage and blood gas analysis and creatinine kinase in the most severely ill children with advanced scoliosis or neuromuscular disorders.

ANAESTHESIA

The simultaneous use of general and regional anaesthesia best prevents sensitisation and significantly improves the outcomes of pain management in children undergoing orthopaedic surgical procedures. The use also reduces the risk of general anaesthesia-related adverse side effects [12, 13]. Standard general anaesthesia (VIMA or TIVA) should always be provided with intubation during surgeries in ventral decubitus positions. Laryngeal mask airway (LMA) or face mask ventilation should be adequate for other procedures. Muscle relaxants are most commonly required only for intubation because of lower muscle mass and lower muscle tone. Relaxation may be useful for more complicated procedures.

REGIONAL ANAESTHESIA

Regional anaesthesia (central or peripheral block) should be performed on anaesthetised or sedated children. However, regional anaesthesia prevents assessments of paresthesias or pain during drug injections to extra- and perineural spaces. Therefore, ultrasound techniques are recommended to increase the efficacy of anaesthesia and patient safety. The use of ultrasound prolongs the anaesthetic management, but it is provides a quick, gentle and painless awakening and suitably long postoperative analgesia (especially when continuous techniques are used). The anaesthetic doses may also be reduced, which decreases the risk of adverse effects, such as respiratory and circulatory depression, post-anaesthesia excitation, postoperative nausea and vomiting [14].

The following anaesthetic methods are suggested:

1. Spinal block: children < 5 years of age – 0.5% hyperbaric bupivacaine (0.5 mg kg^{-1}), > 5 years of age — 0.4 mg kg^{-1} 0.5% hyperbaric bupivacaine plus 0.005 mg kg^{-1} morphine (approved for spinal administration). The maximum dose of a local anaesthetic is 10 mg.
2. Lumbar epidural block: a test dose of adrenaline — 0.25 μg kg^{-1} (max. 1 ml), a saturating dose of 0.5 mL kg^{-1} of 0.2% ropivacaine or 0.25% bupivacaine combined with fentanyl (2 μg kg^{-1}) or sufentanil (0,2 μg kg^{-1}), followed by continuous infusion: 0.3 mg kg^{-1} h^{-1} of 0.2% ropivacaine + 1 μg kg^{-1} h^{-1} of fentanyl or 0.1 μg kg^{-1} h^{-1} of sufentanil (flow 4–8 mL h^{-1}); postoperative analgesia – 0.1–0.2% ropivacaine or 0.125% bupivacaine + sufentanil 0.033 μg kg^{-1} h^{-1} or morphine 0.03 mg kg^{-1} (infusion 0.1–0.2 mL kg^{-1} h^{-1}) [14]. Minimum cardiotoxicity and a slighter paralysis of motor nerves and muscles dictate the choice of ropivacaine. An alternative to opioids is the addition of 2 μg kg^{-1} clonidine or 1 μg kg^{-1} dexmedetomidine [16].

Continuation of local anaesthetic infusion without opioids is advisable prior to planned extubation. Standard monitoring during anaesthesia is generally provided, except for scoliosis and spine procedures, in which the use of somatosensory evoked potentials (SSEPs) or motor-evoked potentials (MEPs) is often indicated. Notably, inhalation anaesthetics (MAC > 1), similarly to propofol (> 6 mg kg^{-1} h^{-1}), inhibit SSEP and MEP, but opioids, ketamine and etomidate, clonidine and dexmedetomidine exert minimum effects.

POSTOPERATIVE ANALGESIA

Pain following orthopaedic surgical procedures substantially impairs the comfort of children. Pain severity may differ greatly from mild (NRS < 4) to strong (NRS > 7). The combination of NSAIDs with paracetamol is the most effective method for the prevention and management of mild and moderate postoperative pain, and the effects of this combination are more pronounced compared to the separate use of each drug. The combined use of these drugs reduces the dose of or avoids the need for opioids [17, 18]. Nalbufin may be useful in orthopaedics because it exerts smaller depressive effects on the respiratory system (Table 1 [19]).

ANAESTHESIA IN OPHTHALMOLOGY

Ophthalmic procedures are currently performed in preschoolers, school-aged children, newborns, and premature infants. Most of these procedures are elective. Emergency ophthalmic surgeries predominantly include children with eyeball injuries. Most eye procedures in children are performed under general anaesthesia, and strabotomy is the most common surgical procedure. Successful ophthalmic examinations for accurate assessments of the anterior eye and eye fundus, in particular with scleral indentation and intraocular pressure measurements, and additional examinations (e.g., electrophysiological testing) require general anaesthesia and sedation in small and uncooperative children. Ophthalmic examinations under sedation or general anaesthesia in paediatric ophthalmology are essential to assess eyeball injuries, inflammatory processes, intraocular tumours (including retinoblastoma), glaucoma, cataract or retinal diseases [20-23]. Complete immobilisation is needed during ophthalmic procedures, especially for surgeries in

Table 1. Preparation of a child for dental procedures

Concomitant diseases	Preparation	ASA score
A healthy child, autism	Not required	I
Down's syndrome	Assess the cardiovascular system, provide cervical spine stabilisation, remember to reduce the opioid dose	I–III (depending on heart defect)
Diabetes	Familiarise with the treatment modality. In children with pumps, do not discontinue the infusion, check the glucose concentration 2 times during surgery and before transferring the child	II
Cardiovascular disease, (heart defects, cardiomyopathies)	Familiarise with echocardiographic findings performed during 3 pre-anaesthesia months. In cyanotic defects — blood tests are needed	I–IV (depending on heart defect)
Craniofacial defects	Prepare a difficult airway kit	II–III
Infantile cerebral palsy	Assess the child's nutritional state; perform blood tests. Remember not to withdraw antiepileptic drugs. Limit the use of muscle relaxants (smaller doses required)	II
Rare diseases	Familiarise thoroughly with the disease, www.orpha.net is recommended [31]. Adjust the management to a particular disease. In mucopolysaccharidosis — prepare a difficult airway kit	I–III

which the eyeball must be opened, e.g., cataract removal or vitrectomy.

PREPARATION FOR ANAESTHESIA

Beside routine familiarisation with the medical records of previous anaesthetic procedures, the preparation for general anaesthesia in children qualified for ophthalmic surgery should include standard physical examinations. Notably, paediatric ophthalmic problems that require surgical treatment are often the symptoms accompanying severe systemic diseases or congenital developmental defects. The feasibility of upper airway maintenance and mask ventilation must be evaluated in cases with concomitant craniofacial defects. Specialist devices for difficult endotracheal intubation should be at hand. The child's neurological status and pharmacological treatment provided should also be assessed. The risk of oculocardiac reflex, PONV, and agitations during awakening from anaesthesia should always be considered.

The effects of drugs and anaesthetic techniques on intraocular pressure (IOP) should be considered, and normal IOP should not exceed 20 mmHg. Increased venous pressure (Trendelenburg position, cough, Valsalva manoeuvre, increased intrathoracic pressure) caused by impaired eye fluid drainage and arterial pressure above 30% of the baseline value increases IOP [20, 23].

PREMEDICATION

Recommendations for premedication are universal and identical to children undergoing general anaesthesia for other surgical procedures. However, the majority of children who are qualified for ophthalmic procedures have other severe diseases, e.g., congenital heart defects. The effects of premedication drugs on the child's general health must be considered. Standard prophylaxis should be provided, e.g., i.v. dexamethasone 0.1–0.15 mg kg^{-1}, in ophthalmic procedures accompanied by PONV [20]. Children scheduled for surgeries with a high risk of oculocardiac reflex should receive prophylactic post-induction i.v. atropine (20 µg kg^{-1}), which does not always eliminate the risk in question, but it substantially reduces its severity and duration. The use of additional doses of 5–10 µg kg^{-1} is often necessary. Adrenaline is seldom used, but it should always be available. The recommended dose ranges from 1 to 10 µg kg^{-1}. Other strategies that help eliminate the oculocardiac reflex issue are the use of local anaesthesia with lidocaine or intravenous anaesthesia with ketamine (10–12 mg kg^{-1} h^{-1}) [20, 23, 24].

ANAESTHESIA

Inhalation or intravenous anaesthesia is recommended using standard methods and drugs adjusted to the patient's age. There is some controversy over the best method of induction of general anaesthesia in cases of open eyeball injuries, which is associated with a possible rapid increase in IOP and risk of aspiration [20, 25]. The best method in these cases is rapid intravenous induction with a higher dose of rocuronium (1.2 mg kg^{-1}), which ensures excellent intubation conditions. Succinylcholine should not be used because of the risk of IOP increases. Intravenous opioids (fentanyl, remifentanil, morphine) are also

recommended to eliminate the adverse intubation-related haemodynamic reaction, but these drugs increase the risk of nausea and vomiting, which increases the risk of IOP. Endotracheal intubation is preferable to provide a secure airway in children during anaesthesia for most ophthalmic procedures. LMA or a face mask that does not limit the operative field is preferable for short-term procedures (e.g., ophthalmic testing) [20, 21].

MAINTENANCE OF ANAESTHESIA

Maintenance of inhalation and intravenous anaesthesia should be suitably tailored to individual patients and the skills of attending anaesthetists.

AWAKENING

Full reversal of neuromuscular blockade is crucial during awakening from anaesthesia (TOF-0.9). An increase in IOP should be avoided, but very short periods of increased IOP do not negatively affect eye surgery. Therefore, most reports suggest full awakening of a child prior to extubation. However, there are specialists who prefer extubation in anaesthetised children to prevent coughing and resultant increases in intraocular pressure.

LOCAL ANAESTHESIA

Local anaesthesia is used primarily for intraocular pressure examinations or removal of sutures in older and cooperative children [20, 26].

Notably, ophthalmic drugs administered intraoperatively into the conjunctival sac are mainly absorbed from the nasal mucosa and exert systemic effects. Therefore, the influence of these drugs (e.g., neosynephrine) should always be considered.

SPECIAL CASES

Several strategies are advocated to avoid postoperative nausea and vomiting. Avoidance of opioids and replacement with non-opioid analgesics during strabotomy reduces the incidence of PONV. Whenever opioids must be used, short-acting agents are preferred (e.g., remifentanil, alfentanil). Adequate fluid therapy to correct fluid deficits caused by limited feeding in the preoperative period and the use of isotonic fluids, even up to 30 mL kg^{-1}, substantially decreases the incidence of PONV. Pharmacological prevention of nausea and vomiting in this multimodal management is pivotal. The 5-HT_3 antagonists are used (ondansetron 0.1 mg kg^{-1}) in combination with dexamethasone (0.1–0.15 mg kg^{-1}) or other drugs. N_2O should be avoided during anaesthesia. Beneficial antiemetic effects may be achieved with propofol [20, 23, 26].

ANAESTHESIA IN DENTISTRY

Dental procedures under anaesthesia are generally performed in children with accompanying diseases or communication deficits (e.g., autistic children) [27, 28]. Oral cavity sanitation in healthy children does not require special preparation or additional examinations (except for blood group determinations) [29]. The required fasting time is 6 hours after solid foods and 2 hours after clear liquids [30].

PREPARATION FOR ANAESTHESIA

The child's evaluation before anaesthesia for dental procedures should involve the detailed requirements presented in Table 1. Special attention should be paid to wobbly teeth.

PREMEDICATION

Oral or rectal midazolam (0.2 mg kg^{-1}) in combination with ketamine (3 mg kg^{-1}) (maximum 15 mg of midazolam and 200 mg of ketamine) is advisable in frightened children (often healthy) and children with Down's syndrome or autism. Premedication depends on a particular situation in the remaining patients.

ANAESTHESIA

Intravenous anaesthesia with propofol or inhalation anaesthesia with sevoflurane is used in combination with muscle relaxation using vecuronium or rocuronium in doses adjusted to age. Dental procedures without intubation or with a laryngeal mask are not recommended because the anaesthetist and dentist work in the same area. Naso-endotracheal intubation is preferable when the tube can be inserted bloodlessly. Oral-endotracheal intubation is performed in other cases. The oral cavity should be thoroughly packed with a moistened bandage after intubation.

Conduction analgesia provided by the attending dentist is indicated before tooth extractions. Paracetamol (20 mg kg^{-1}) should be given intravenously for extractions and root canal treatment procedures.

MAINTENANCE OF ANAESTHESIA

TIVA is preferred: infusion of 3–4 mg kg^{-1} h^{-1} propofol and analgesia with 3–5 µg kg^{-1} fentanyl, 1x. The dose of fentanyl may be repeated, or remifentanil (0.25 µg kg^{-1} min^{-1}) may be used. Sevoflurane may be used, but it is not recommended because of post-anaesthetic anxiety, which may persist later at home [32]. Standard monitoring is used, except for specific indications.

AWAKENING

The packing should be removed prior to awakening, and meticulous laryngoscopy of the oral cavity performed

to ensure that no cotton rolls or tooth fragments remain. Cough must be avoided before extubation because the incidence of laryngospasm in dentistry is high. Intravenous diazepam (0.1 mg kg^{-1}) is effective with compression of mandible angles and hypertension in the paraglottic space using a tight face mask (100% O_2) in cases of glottidospasm. A muscle relaxant may be applied as an alternate approach. Intubation should not be attempted.

The child is usually sent home after the procedure once circulatory-respiratory efficiency has been examined. Indications for hospitalisation depend on individual cases.

ANAESTHESIA IN EMERGENCIES

PREPARATION FOR ANAESTHESIA

Emergency paediatric patients are generally transported to the nearest hospital which is not usually dedicated to children. Therefore, each anaesthesiologist should know the basic rules of child stabilisation, especially when emergency anaesthesia is needed. Assistance of another anaesthesiologist and a second nurse is useful, if possible, and a laryngologist may also be needed in cases of anticipated difficult airway. It is advocated to use the applications available for mobile devices to select the instuments of proper sizes and suitable drug doses to avoid possible mistakes [33, 34]. The primary rule is maximal stabilisation of the child prior to transport or anaesthesia. The "scoop and run" approach is applied extremely rarely, i.e., when the improvement may be achieved only in the specialist hospital setting [35]. Intubation and mechanical ventilation are generally required in emergency cases, particularly when transport or surgery is planned. Before intubation of children in shock, attempts must be made to optimise their condition [35,36]. It is essential to obtain i.v. access, but prompt i.o. access should be provided when i.v. access fails. Fluid resuscitation with boluses of isotonic fluid without glucose (20 mL kg^{-1} each) should be administered in non-cardiogenic shock cases. Blood typing is needed, and blood preparations should be prepared and crossmatching performed in cases of bleeding. Coagulation testing should include the concentration of fibrinogen. Point-of-care (POC) ultrasound is extremely useful during the initial period because it enables quick exclusion or diagnoses of pneumothorax, pulmonary oedema, pleural effusion or pericardial tamponade. This technique allows assesses cardiac contractility, diagnoses internal bleeding and estimates the extent of vascular bed filling [37].

PREMEDICATION

Premedication is contraindicated in most cases.

ANAESTHESIA

INDUCTION

Each child should be considered a patient with a full stomach. Passive preoxygenation should be applied in children with impaired upper airways in a reclining position whenever possible. This scenario is the only situation in which the option of choice is inhalation induction with sevoflurane in 100% oxygen following the provision of intravenous access. Induction via the intravenous or intraosseous route is performed in all other cases in children with full stomach. Intubation is the strategy of choice. Critically ill children have reduced oxygen reserves, and controlled rapid sequence induction (RSIc) should be used. The child is ventilated very gently with a face mask, not exceeding 10 cm H_2O of inspiratory pressure (as in all other cases in small children with full stomach), after drug administration but before intubation [38].

EDELO may be applied (Table 2) while preparing for intubation, in which:

E STANDS FOR EQUIPMENT

Whether appropriate devices have been prepared should be investigated (see Table 3 – a checklist). Use of a tube with a cuff one size smaller than the cuff for difficult airway is acceptable in emergency cases. Oral intubation is recommended, unless the provider is experienced in nasal intubation and there are no contraindications of clotting disorders or suspected cranial base fractures. Proper tube fixation is crucial. The cervical spine should be manually immobilised during intubation (by an assistant) in children with traumas and the neck protected with a collar. Moreover,

Table 2. Indications for intubation in emergencies

Indications for intubation in emergencies
CNS — GCS < 9, drug-resistant status epilepticus (exclude hyponatraemia and hypoglycaemia), prevention of secondary brain injury
A — provision of airway patency and protection
B — respiratory failure
C — reduction of oxygen consumption and optimisation of its supply (e.g., sepsis, cardiogenic shock)
Other: surgery required

CNS — central nervous system; GCS — Glasgow Coma Scale

Table 3. A checklist before transport/anaesthesia

Monitoring	
Minimum: SaO_2, ECG, arterial pressure, E_TCO_2, temperature	Yes/No
Equipment + drugs	
Suction device + suction catheters, fixation of the endotracheal tube, devices for ventilation = face masks, a self-expanding bag or Jackson-Rees system, endotracheal tubes, guides, laryngoscopes — at least 2 with blades of different sizes, laryngeal masks	Yes/No
Oxygen source and ventilator: initial FiO_2 so as SaO_2 > 93%, Positive inspiratory pressure (PIP) to achieve visible movements of the thorax, positive end-expiratory pressure — min. 5, f — physiological for age)	Yes/No
Infusion pumps	Yes/No
Drugs: ketamine/etomidate/thiopental/propofol, rocuronium/succinylcholine, sugammadex, fentanyl/morphine/remifentanil/sufentanil, midanium, atropine, adrenalin, dopamine, dobutamine, adrenalin, milrinone, (3% NaCl, 10% mannitol — children with increased intracranial pressure)	Yes/No
Isotonic infusion fluids , e.g., compound electrolyte solution/Ringer's solution/paediatric fluid, 0.9% NaCl, 10% glucose (1–2 mL kg^{-1} i.v. to correct hypoglycaemia	Yes/No
Desirable parameters	
SaO_2 > 93%, E_TCO_2 35–45 mm Hg (in lung injuries- permissive hypercapnia, systolic arterial pressure min. 70 + 2 × age (≤ 10 years), then 90 mm Hg	Yes/No
Efficient sedation (+ relaxation)	Yes/No

a gastric tube must be inserted through the nose (the same contraindications as for nasal intubation) or mouth. The child cannot be allowed to breath spontaneously via the endotracheal tube.

D STANDS FOR DRUGS

It is necessary to prepare the drugs for induction and adrenaline in case resuscitation is needed. The choice of drugs depends on the patient's condition. The drug of choice for shock is ketamine, but unanticipated decompression of the circulatory system may develop even when ketamine is used. Propofol is recommended in haemodynamically stable children with full stomachs. Rocuronium or succinylcholine is recommended for muscle relaxation. Drugs for anaesthesia maintenance should also be prepared.

EL STANDS FOR EMERGENCY LOGISTICS

It should be assumed that problems are likely to emerge, and an initial alternative management may be needed. For example the use of LMA or a bougie may be needed in failed intubation (plan A, B, C….).

O STANDS FOR OPTIMISATION OF PATIENT'S CONDITION

The vascular bed should be earlier filled via the administration of boluses of isotonic crystalloids without glucose (20 mL kg^{-1} in each bolus over 5-10 minutes using a syringe) and with catecholamines to reduce the risk of arterial pressure decreases or circulatory arrest in septic shock. The first-line drug is dopamine, which is administered peripherally at a maximum concentration of 0.1% in a syringe pump at 5–15 μg kg^{-1} min^{-1} [36]. Drugs that improve cardiac contractility are used in cardiogenic shock, e.g., dopamine or dobutamine in doses of 5–10 μg kg^{-1} min^{-1} or milrinone at 0.4–0.7 μg kg^{-1} min^{-1}. Small doses of adrenaline (0.01–0.05 μg kg^{-1} min^{-1}) and diuretics are used when the previous drugs are ineffective. Blood transfusion preparations may be necessary in cases of haemorrhagic shock. O Rh negative blood or type AB fresh frozen plasma may be required in massive haemorrhages.

M STANDS FOR MONITORING

The patient should be monitored, and capnography should be available whenever possible.

MAINTENANCE OF ANAESTHESIA

Combined anaesthesia is used for maintenance in emergency cases: opioids, an inhalation anaesthetic (most commonly in the mixture of oxygen and air and titrated according to arterial pressure) and non-depolarising muscle relaxants. Hypotension should be avoided in all children, particularly with CNS injuries, because it is likely to reduce cerebral perfusion pressure. Normoxaemia and normocapnia should be maintained (except for cases with sudden increases in intracranial pressure that may result in impaction, in which hyperventilation is indicated). Regional analgesia is rarely used in emergency cases of severely ill children. However, it is sometimes used during the postoperative period, once the permissible dose has been calculated.

Central vascular access is recommended in the monitoring of critically ill children. A safe option is external jugular vein or femoral vein cannulation, but internal jugular vein US--guided cannulation is acceptable. Invasive arterial pressure or low-invasive cardiac output measurements are advocated in haemodynamically unstable children. Core and peripheral temperature should definitely be monitored (the optimal difference should not exceed 1°C). A urinary catheter should be inserted. Anaesthesia depth monitoring is useful in this group of patients.

AWAKENING

Generally, critically ill children are not awoken immediately after procedures, and the treatment is continued in intensive care units or postoperative intensive care units. Transport to a specialist centre is often indicated for final treatment of trauma, once suitable devices and drugs have been provided, if the procedure was to control bleeding provisionally (Table 3).

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